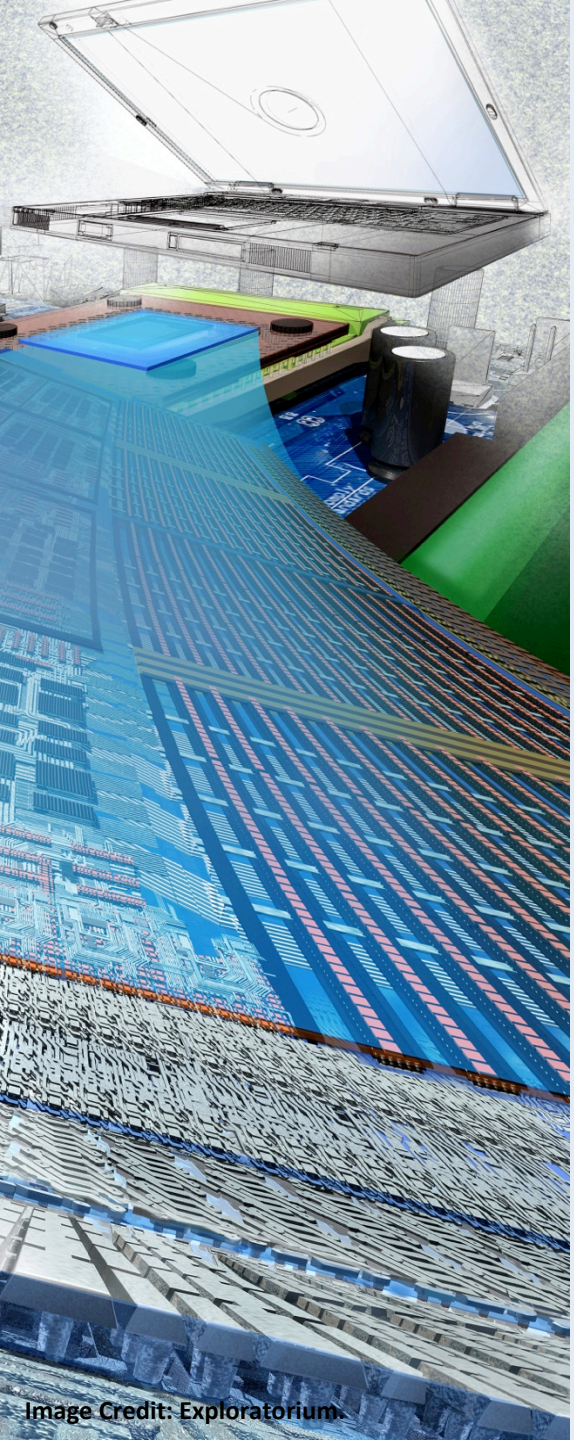

Image Credit: Exploratorium.

NSF and CISE Update:
An Expanding and Expansive View of Computing

Jim Kurose

Assistant Director, NSF

Computer & Information Science & Engineering

June 2015

Overview

- Welcome and thanks
- Talkin' about CISE
- CISE Update
  - Budget & Programmatics
- Partnerships
- Expanding and Expansive View of CISE

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Thank you, Farnam

- leadership
- stewardship
- team-building

Farnam Jahanian

CISE AD March 2011 – July 2014

Thank you, Farnam

… and Suzi and Erwin,

… and the entire CISE team!

Welcome New AC Members!

- Thomas Cortina, CMU
- Michael Franklin, UC Berkeley
- Vijay Kumar, UPenn
- Margaret Martonosi, Princeton
- Padma Raghavan, Penn State

A huge thank you to all AC members!

Welcome New CISE Staff!

ACI

Amy Friedlander
Bill Miller
Sushil Prasad
Rajiv Ramnath
Ceren Susut

CCF

Jack Snoeyink
Teresa Thurtle

CNS

Amy Apon
Jack Brassil

IIS

Jasmine Owens
Lynne Parker
Tyffani Smith
Angela Wilson

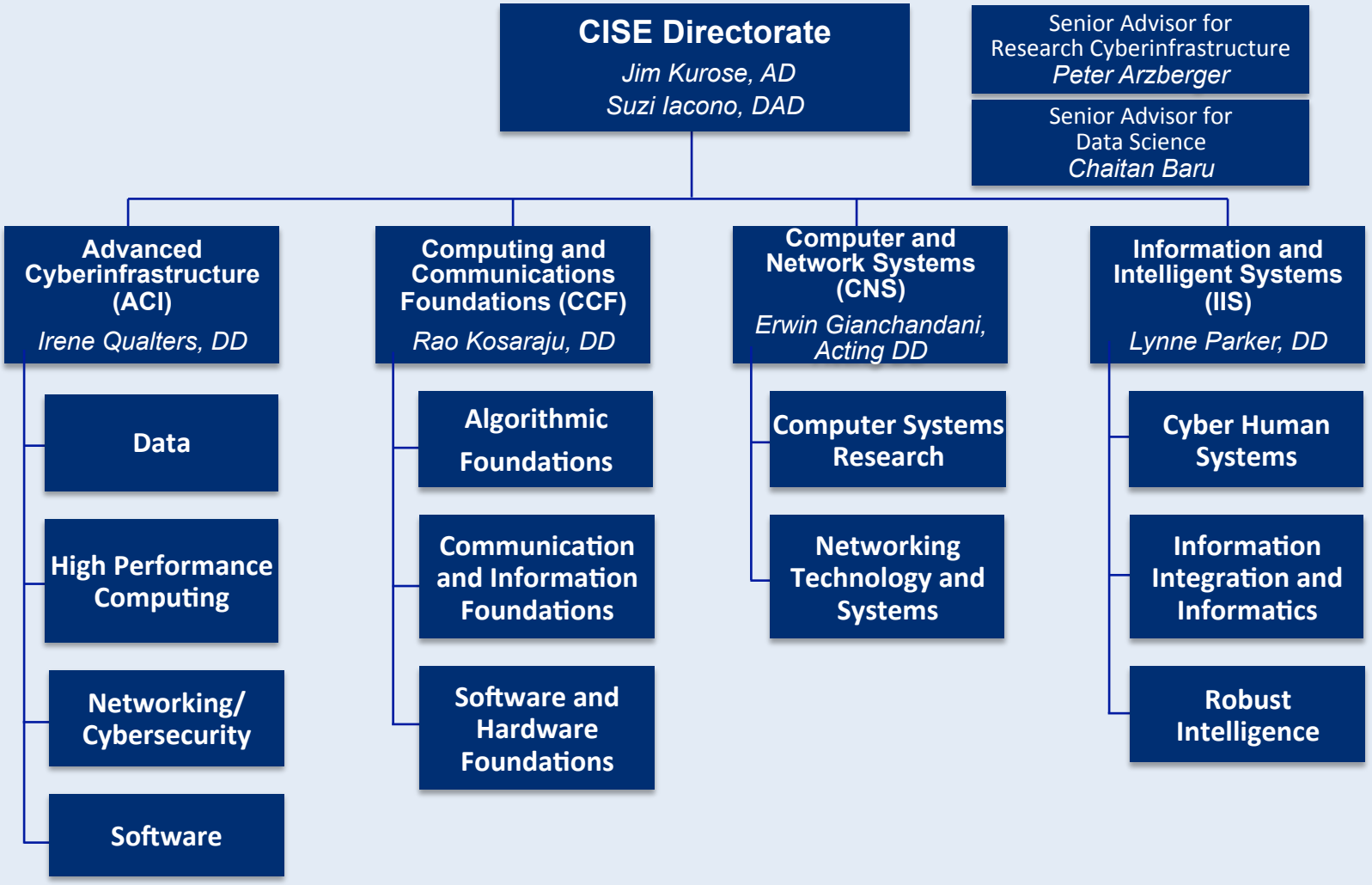
OAD

Peter Arzberger

Aloha, Keith Marzullo!

- On detail from NSF to OSTP, as Director of the Federal Networking and Information Technology Research and Development (NITRD) National Coordination Office (NCO)

CISE Organization



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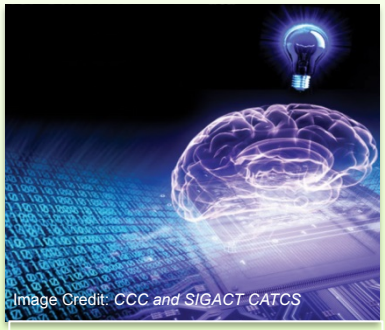
Computing's Economic, Societal Context

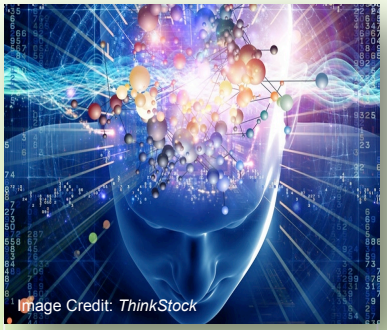
- Computing is at the center of an ongoing, long-term societal transformation
- Advances in computing, communications, information technologies and cyberinfrastructure:
  - underpin economic prosperity, national security
  - drive U.S. competiveness and sustainable economic growth
  - accelerate the pace of discovery and innovation
  - are crucial to achieving national and societal priorities, including education and workforce development

Computing Frontiers, National Priorities



From Data to Knowledge to Action

Manufacturing, Robotics, & Smart Systems

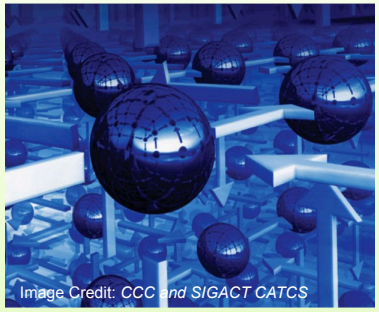


Understanding the Brain

Secure Cyberspace

Education, Workforce Development

Augmenting Human Capabilities



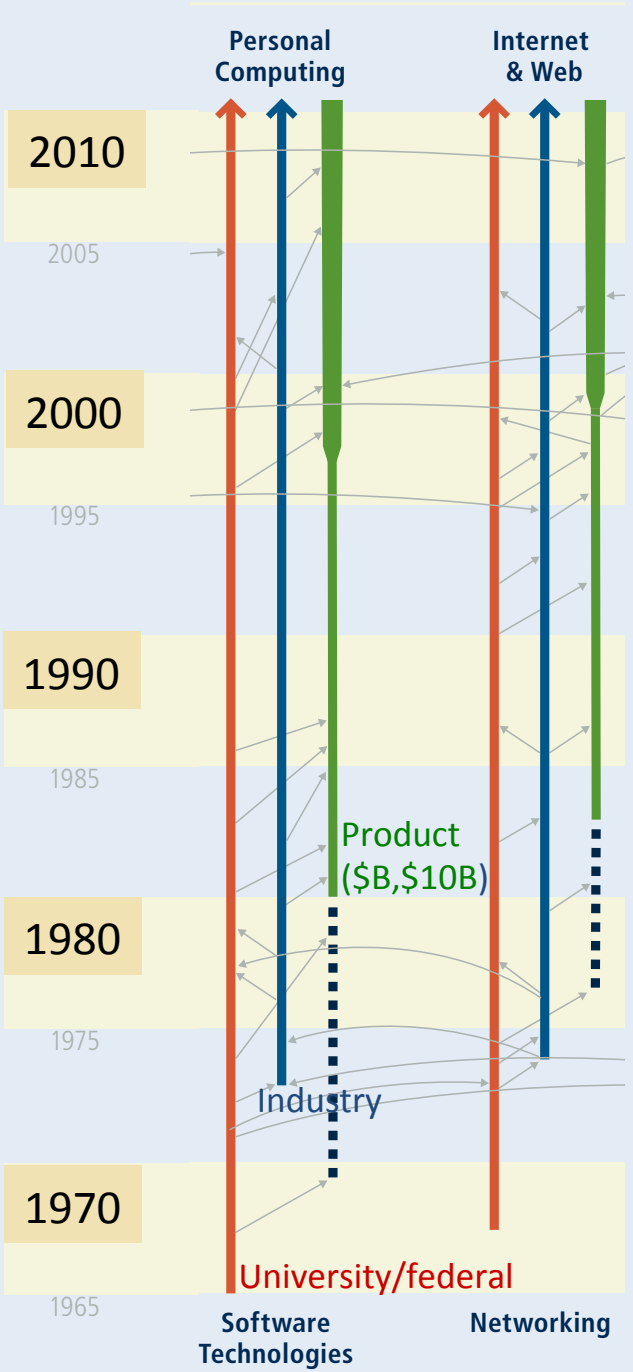
Expanding the limits of computation

Economic Impact of IT is Enormous

- Growth of IT industry coupled with productivity gains across the entire economy have had enormous impact.
- IT industries accounted for 25% of US economic growth since 1995.
- In 2010, IT industries grew 16% and contributed 5% to overall US GDP.

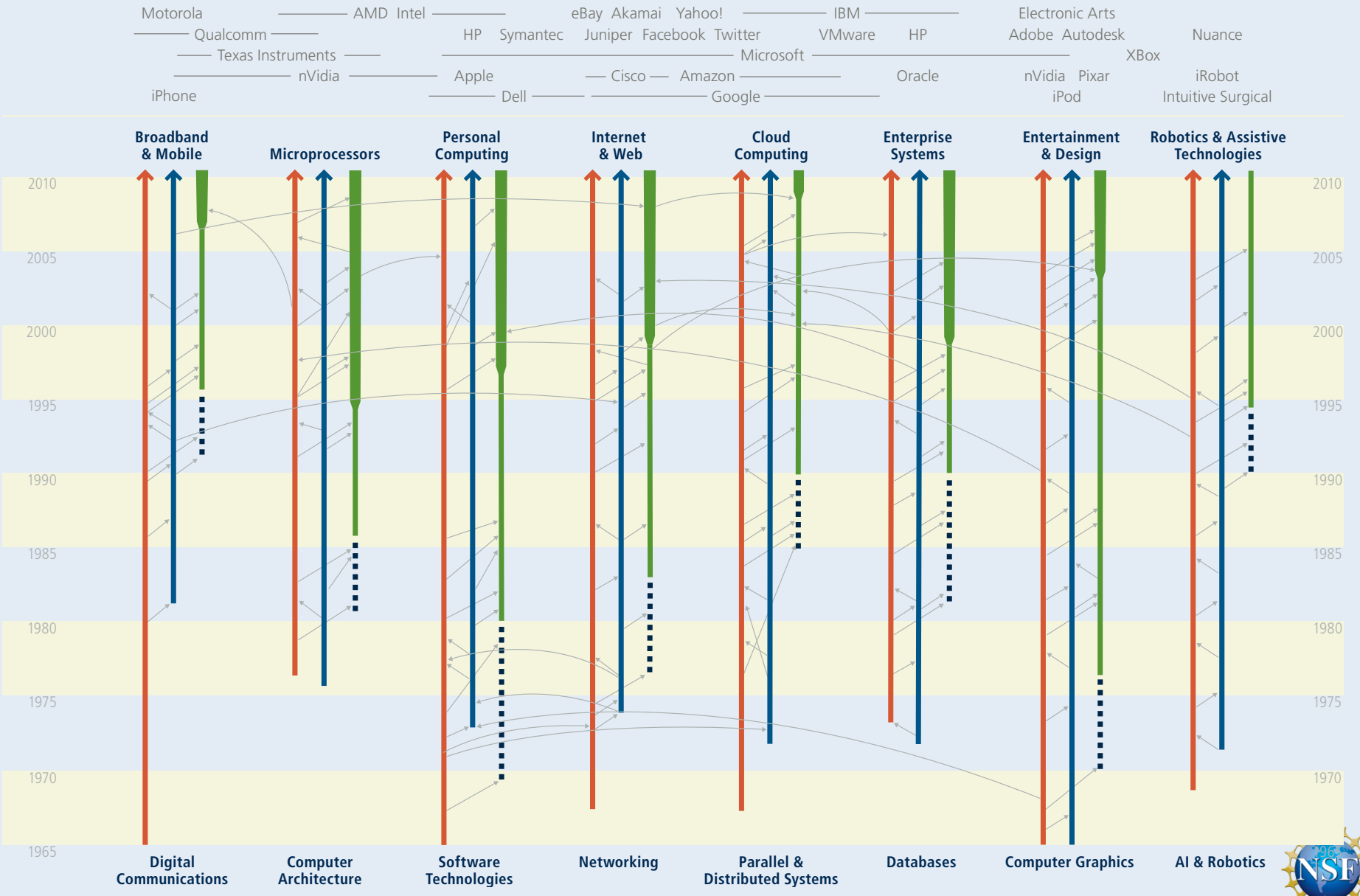
Sources: NRC (2009). *Assessing the Impacts of Changes in the IT R&D Ecosystem*.; NRC (2012). Continuing Innovation in Information Technology.

From federally-funded fundamental computing research …to multi-billion dollar industries



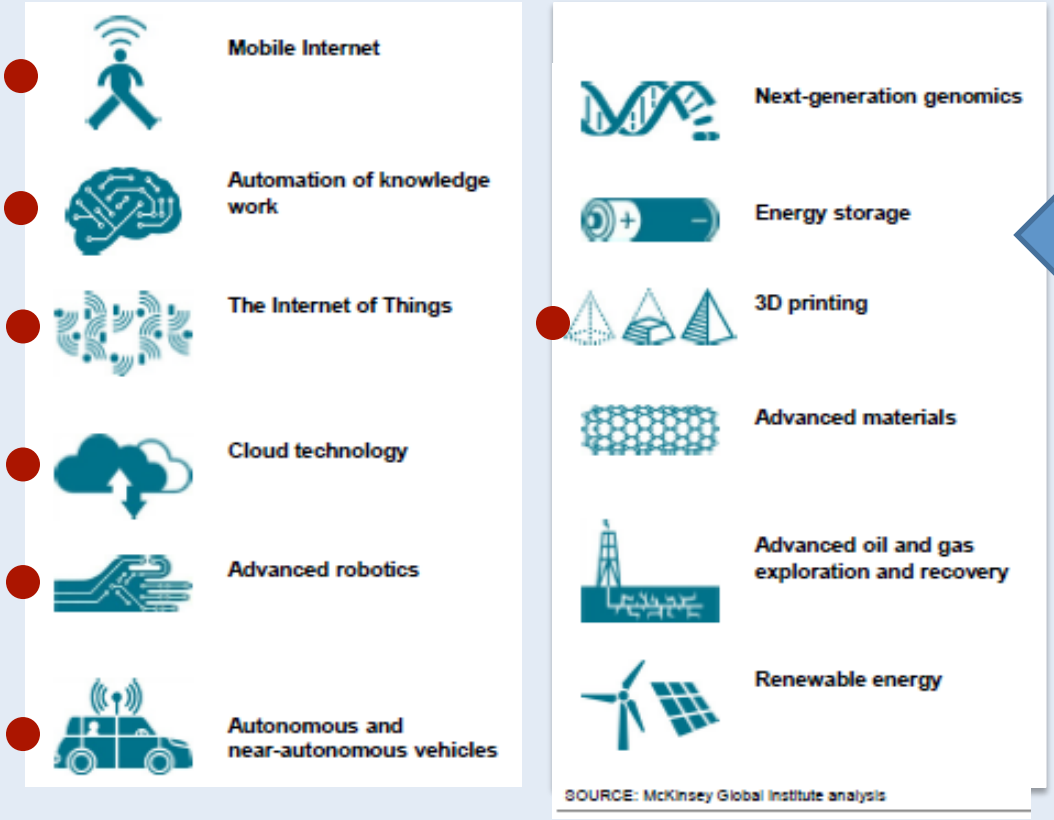
From *Continuing Innovation in Information Technology*, NRC, 2012.

…. across many industries

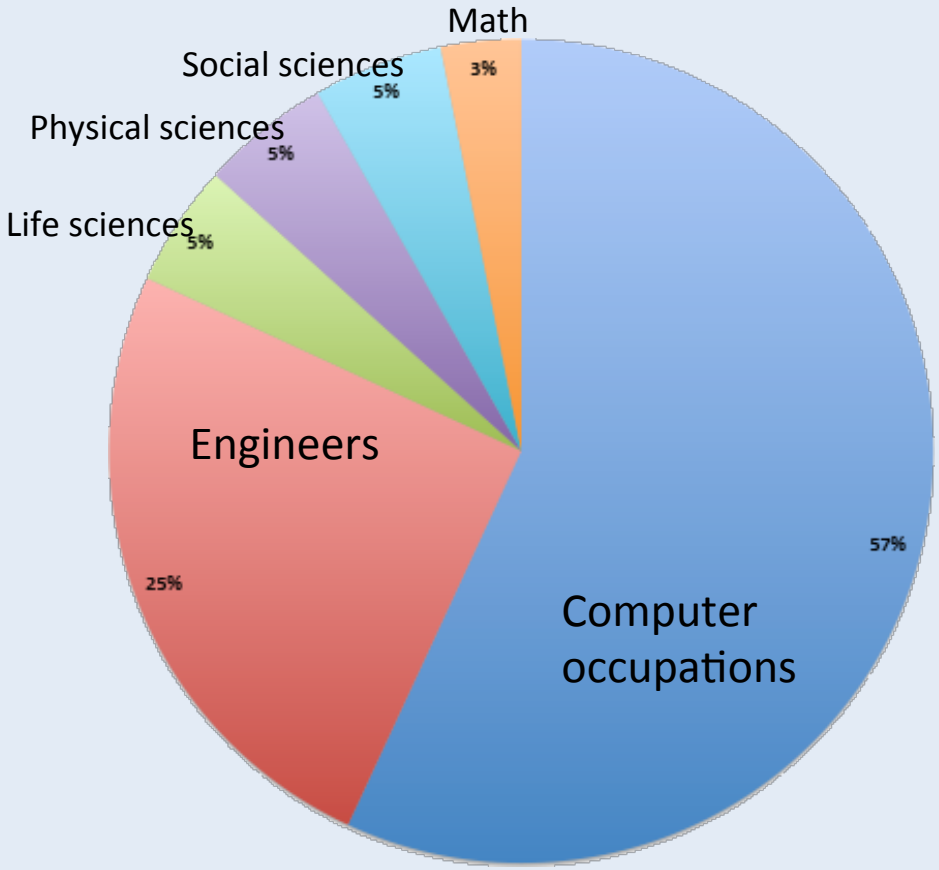


… and this impact will continue

Top twelve economically disruptive technologies (by 2025)



Many STEM Jobs are in Computing



Job Openings 2012 – 2022 (growth and replacement)

US Bureau of Labor Statistics

Data from the spreadsheet linked at http://www.bls.gov/emp/ep_table_102.htm

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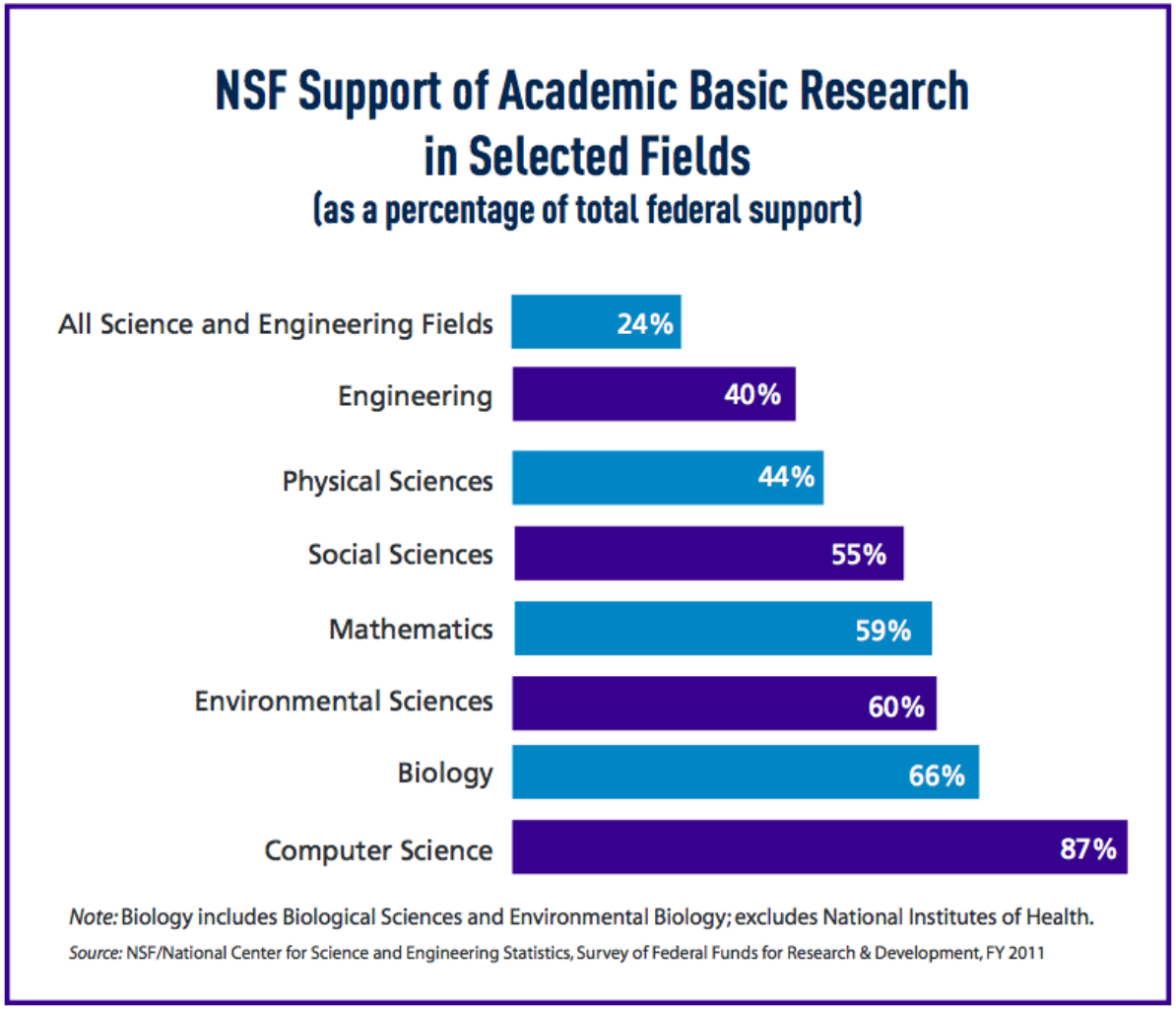
NSF Support for CISE Research: Critically Important

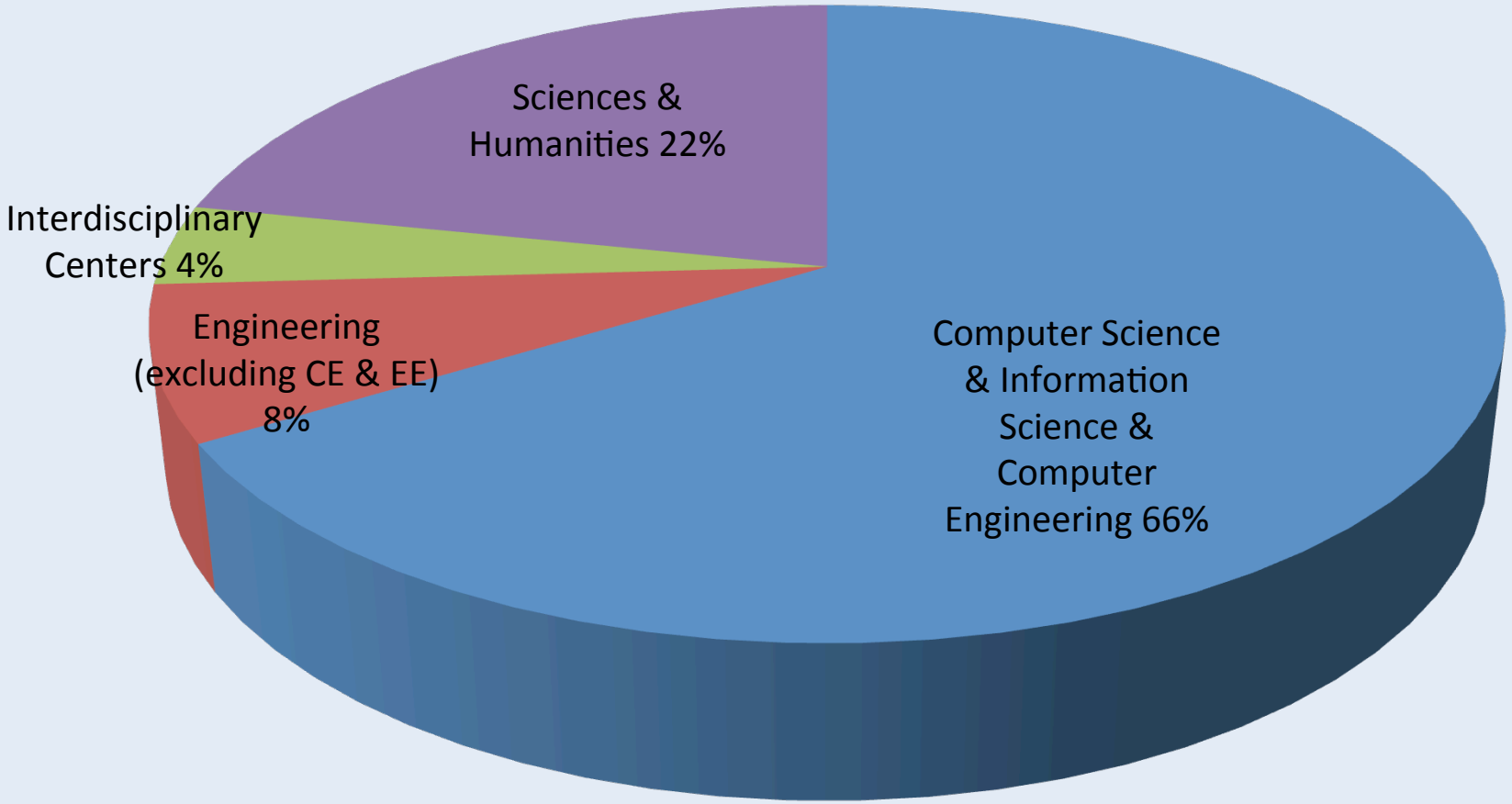


CISE FY 2014 Activities … Reaching People

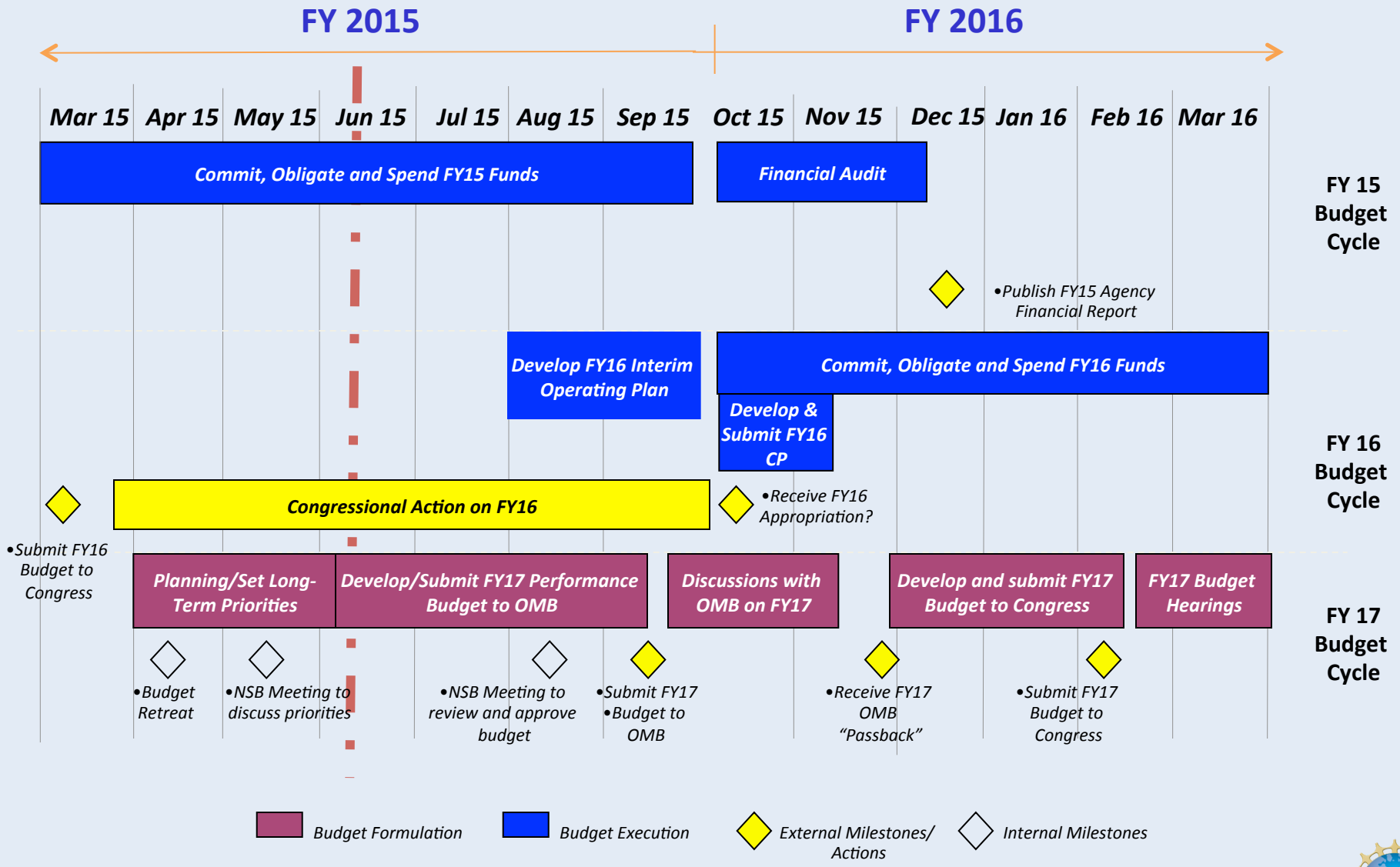
	CISE
Budget	$893M
Number of Proposals	7,436
Number of Awards	1,682
Success Rate	~23%
Average Annualized Award	$199K
Number of Panels Held	302
Number of People Supported	16,774

	CISE
Senior Researchers	6,663
Other Professionals	1,123
Postdoctoral Associates	491
Graduate Students	6,064
Undergraduate Students	2,433

The CISE Community:
FY 2014 PI and Co-PI Departments

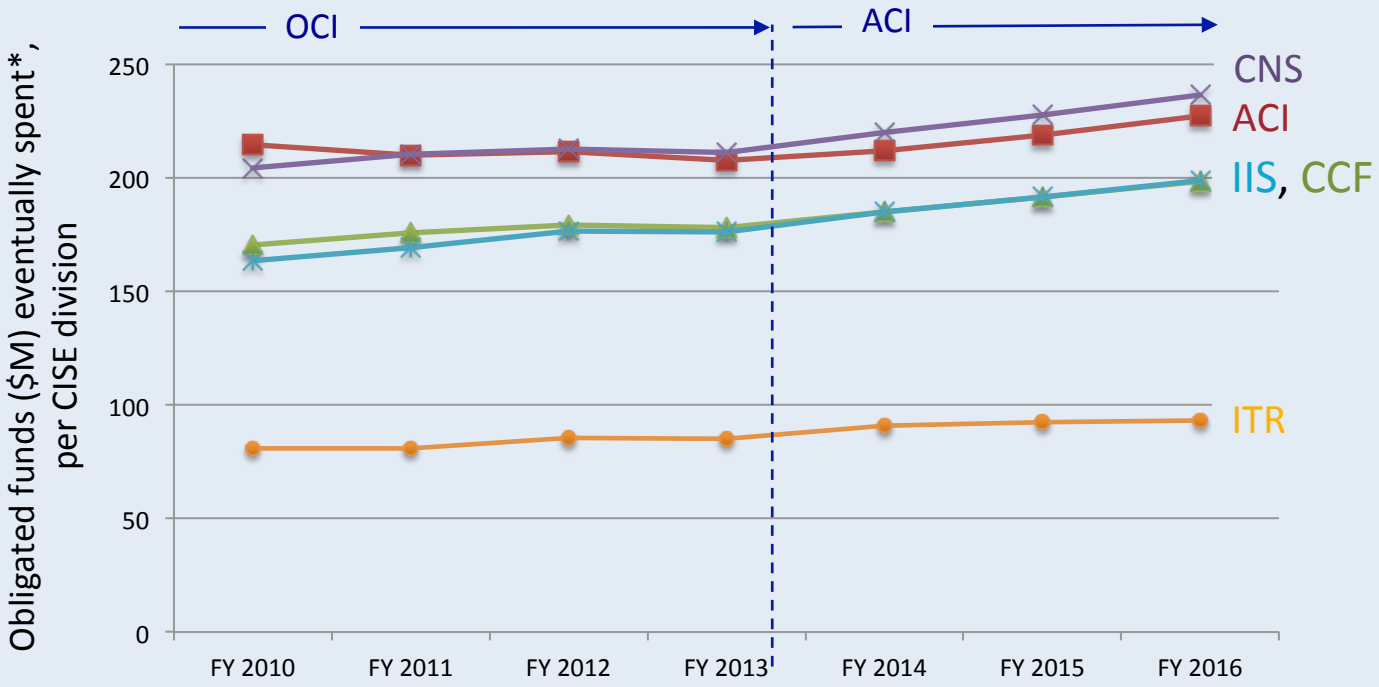


Budget Activity Timeline



Note: Timing of internal deadlines and appropriations fluctuates from year-to-year

CISE Budget History



*Budget Request to Congress shows obligated funds, later deobligated and not spent

FY 2016 Budget Request

NSF

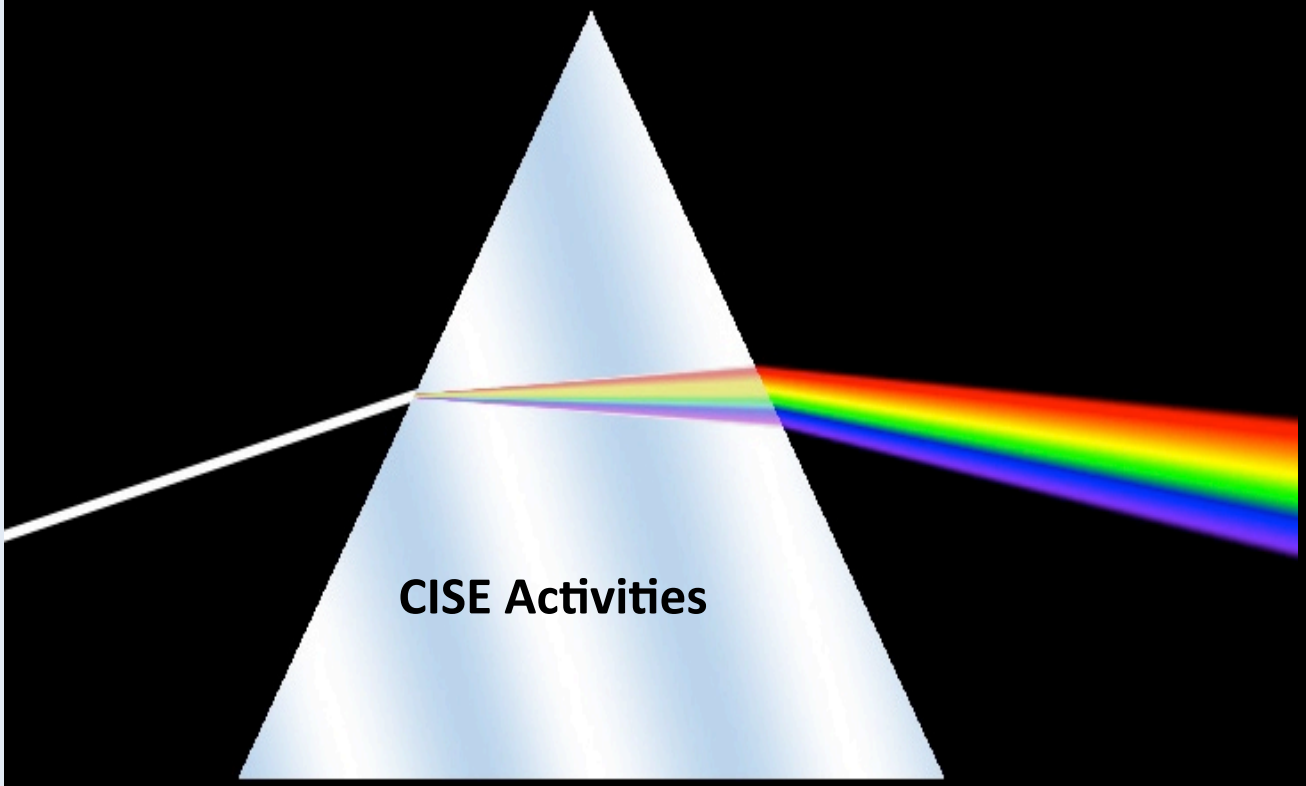
- FY 2016 Budget Request: $7723.55 Million
- Increase over FY 2015 Est: $379.34 Million, +5.2%

CISE

- FY 2016 Budget Request: $954.41 Million
- Increase over FY 2015 Est: $32.68 Million, +3.5%

CISE FY 2016 request is shaped by investments in ***core research, education, and infrastructure programs*** as well as critical investments ***in NSF cross-directorate priorities and programs***.

Budget Prism



Core programs

NSF-wide priorities, programs

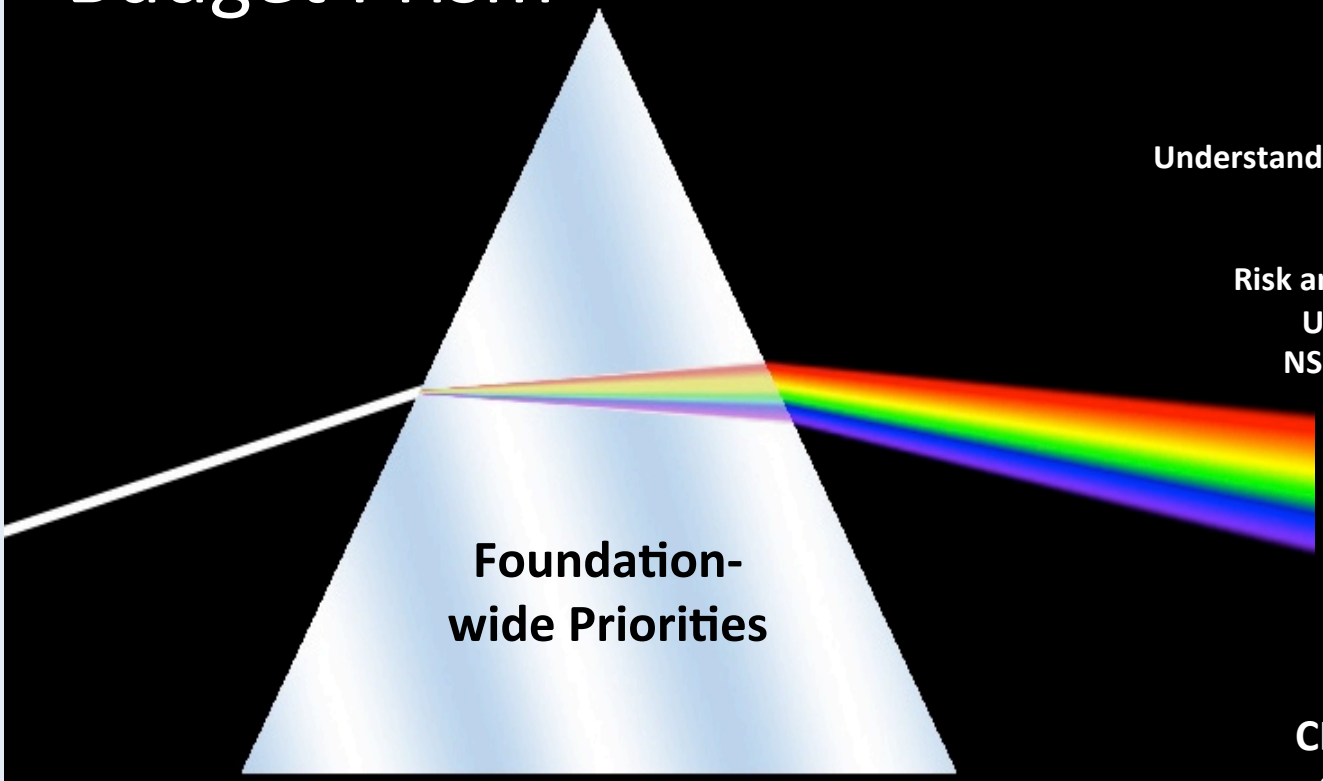
Cross-cutting programs

CISE's Commitment to the Core

CISE continues to cast a wide net and to let the best ideas surface, rather than pursuing a prescriptive research agenda. It engages the research community in developing new fundamental ideas, which are then evaluated by the best researchers through the merit review process.

This process, which supports the vast majority of unclassified computing research in the United States, has led to innovative and transformative scientific results with enormous economic impact and societal benefits.

Budget Prism



Understanding the Brain
INFEWS*
NRT
Risk and Resilience
Urban Science
NSF INCLUDES*

recent and new (*) priorities

CEMMSS
CIF21
SaTC
I-Corps

continuing priorities

CISE Investments in Cross-foundation Priorities

Understanding the Brain (UtB)

Improving understanding of the brain

CISE Investment: $28.58 M

- Partnership among all NSF directorates
- Includes the BRAIN Initiative
- CISE focus:
  - Collaborative Research in Computational Neuroscience (CRCNS)
  - Integrative Strategies for Understanding Neural and Cognitive Systems
  - MIT STC: Center for Brains, Minds and Machines: The Science and the Technology for Intelligence
  - cyberinfrastructure
- Strong community involvement (e.g., CCC)

BRAIN INITIATIVE
BRAIN RESEARCH THROUGH ADVANCING INNOVATIVE NEUROTECHNOLOGIES

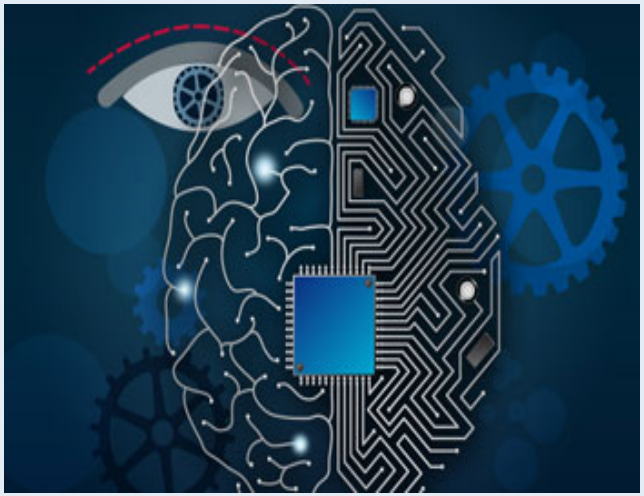


Image Credit: *Christine Daniloff/MIT*

Innovations at the Nexus of Food, Energy, and Water Systems (INFEWS)

Securing and protecting food, energy and water resources

CISE Investment: $13.50 M

- Partnership among all NSF directorates
- CISE focus:
  - New resource management algorithms, architectures
  - Real-time coordination, communications
  - Robust observation, sensing, inference
  - Large-scale data analysis/ management, including modeling, simulation
  - Optimization of complex systems
  - Advancing computational infrastructure

NSF Inclusion across the Nation of Communities of Learners that have been Underrepresented for Diversity in Engineering and Science (NSF INCLUDES)

Broadening participation for those typically underrepresented in STEM fields

- Partnership across *all* of NSF
- Focus:
  - Preparation, participation, and advancement of those traditionally underserved and/or underrepresented in STEM
  - Core CISE focus for many years

Image Credit: *John C. Williams, Humanoid Engineering & Intelligent Robotics (HEIR) Lab, Marquette University*

Smart and Connected Communities

Smart & Connected Communities

- Integrating networked computing systems, physical devices, data sources, and infrastructure
- N**2 network effect: sustainability, livability, equity, efficiency, transportation, energy, safety, environment, education, commerce, health, government

Risk and Resilience

- *Creating new approaches and engineering solutions to make interdependent critical infrastructure systems resilient*
- Partnership among CISE, ENG, and SBE
- CISE Investment: $8.0 M

Urban Science

- *Addressing pressing urban challenges*
- CISE Investment: $3.50 M

Images: *Courtesy of us-ignite.org*

Virtualized, “sliced” infrastructure

Global Environment for Networking Innovations (GENI)

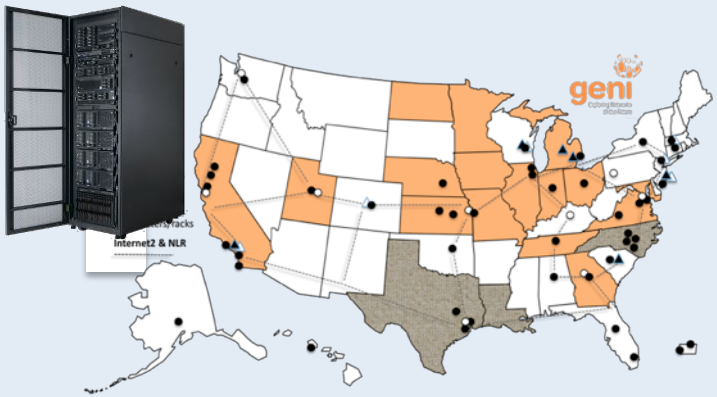
At-scale virtual laboratory enabling experimentation with deeply programmable slices of the network

US Ignite

Stitching together islands of broadband and enabling development of gigabit applications with high-impact public benefit

NSF FutureCloud

Extending virtualization beyond the network to resources in the “cloud”



CISE Research Infrastructure: Mid-Scale Infrastructure - NSFFutureCloud

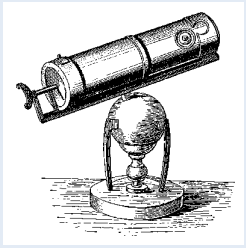
Enabling novel cloud architectures

Program foci:

- Resource sharing in clustered computing
- Virtualization with software-defined networking technologies
- Interplay between applications and cloud computing architectures

Images: Logos from the NSF Cloud projects funded in FY2014

Evolving Research Paradigms



$$\oint \mathbf{E}\cdot d\mathbf{A} = \frac{q_{enc}}{\varepsilon_0}$$

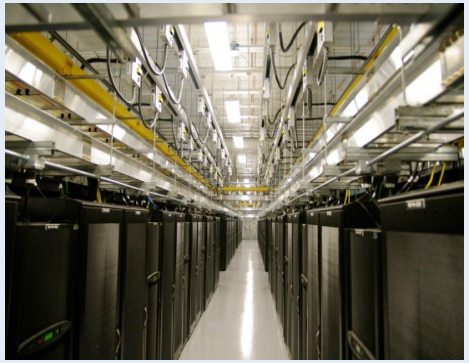
$$\oint \mathbf{B}\cdot d\mathbf{A} = 0$$

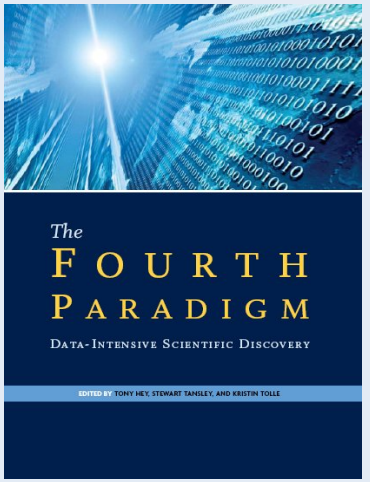
$$\oint \mathbf{E}\cdot d\mathbf{s} = -\frac{d\Phi_B}{dt}$$

$$\oint \mathbf{B}\cdot d\mathbf{s} = \mu_0\varepsilon_0\frac{d\Phi_E}{dt} + \mu_0 i_{enc}$$

$$\frac{\partial \rho}{\partial t} + \frac{\partial}{\partial x_i}(\rho u_i) = S_m$$

$$\frac{\partial}{\partial t}(\rho u_i) + \frac{\partial}{\partial x_j}(\rho u_i u_j) = -\frac{\partial p}{\partial x_i} + \frac{\partial \tau_{ij}}{\partial x_j} + \rho g_i + F_i$$





Experimental Theoretical Computational Data

Data: Critical Across All of Science

NSF'S PUBLIC ACCESS PLAN: NSF 15-52

Today's Data, Tomorrow's Discoveries

Increasing Access to the Results of Research Funded by the National Science Foundation

National Science Foundation

March 18, 2015

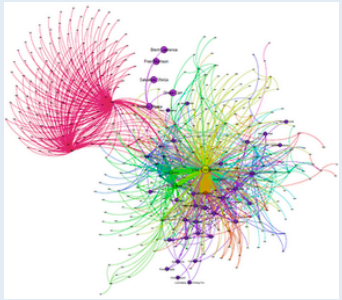
neon
National Ecological Observatory Network, Inc.

EarthCube

nanoHUB
nanoHUB.org
online simulations and more

Powered by iPlant

RDA
RESEARCH DATA ALLIANCE
Research Data Sharing without barriers



LSST
Large Synoptic Survey Telescope

National Science Foundation Research Traineeship (NRT) Program

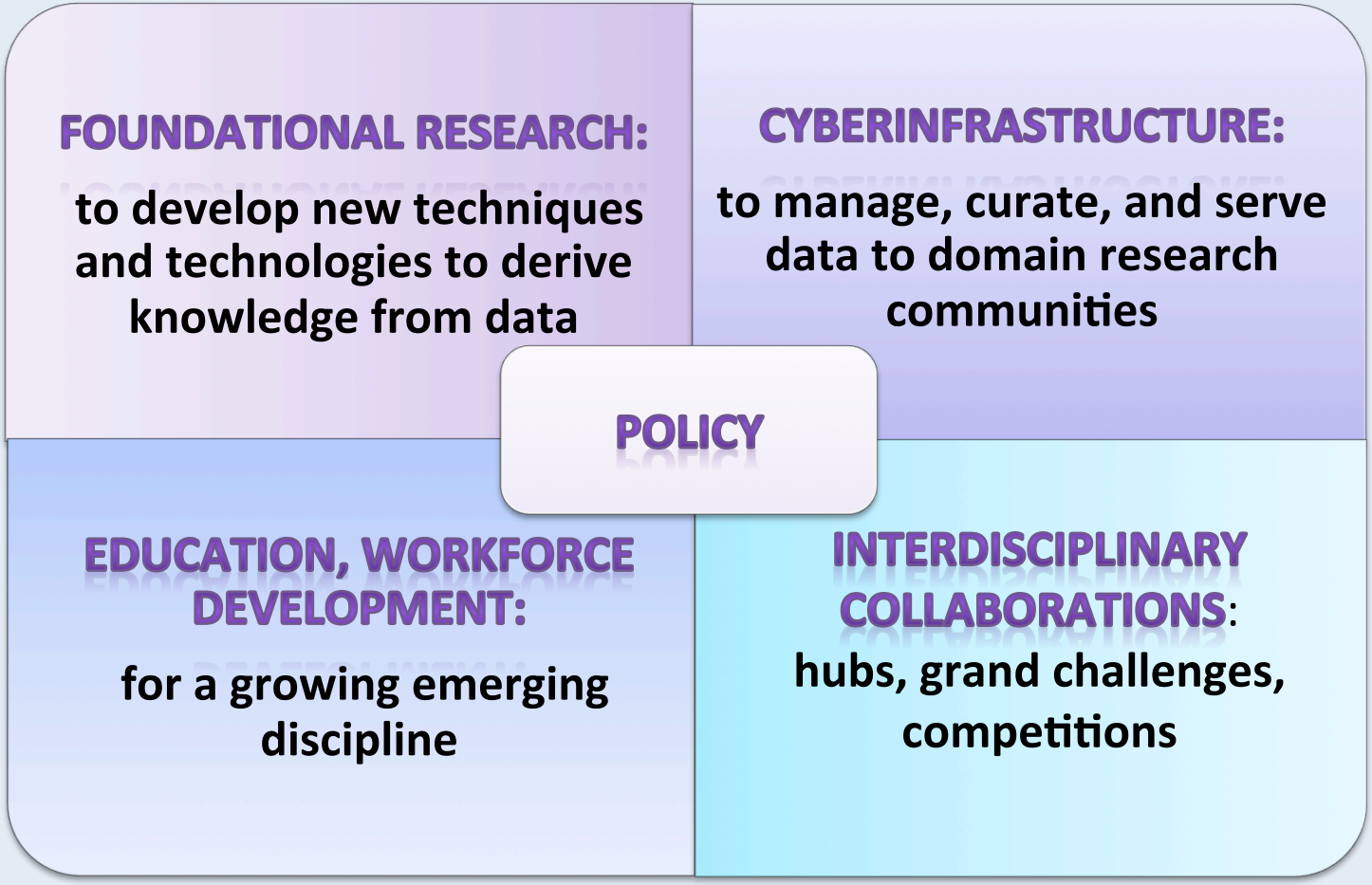
PROGRAM SOLICITATION
NSF 15-542

Social networks

OOI
OCEAN OBSERVATORIES INITIATIVE

NSF

Framework for Data Science Investments



NSF Data Science Activities

FOUNDATIONAL RESEARCH:
CDS&E
BIGDATA
III core program
Data Science Pilots (FY16)
NSFFutureCloud

CYBERINFRASTRUCTURE:
DIBBS
Wrangler, Comet, Jetstream
CC*DNI
Data Science Pilots (FY16)

EDUCATION & WORKFORCE DEVELOPMENT
NRT
Data Science Pilots (FY16)

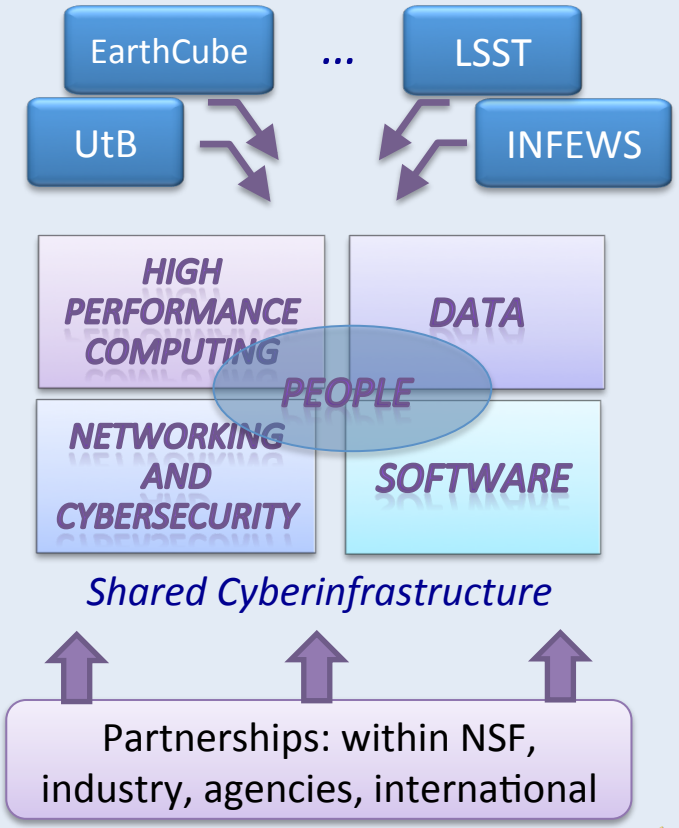
COMMUNITY BUILDING
White House BD Partners WS
Data to Knowledge to Action
BD Strategic Initiatives WS
BD Regional Innovation Hubs
EarthCube
RDA

New CISE-AC working group in data science

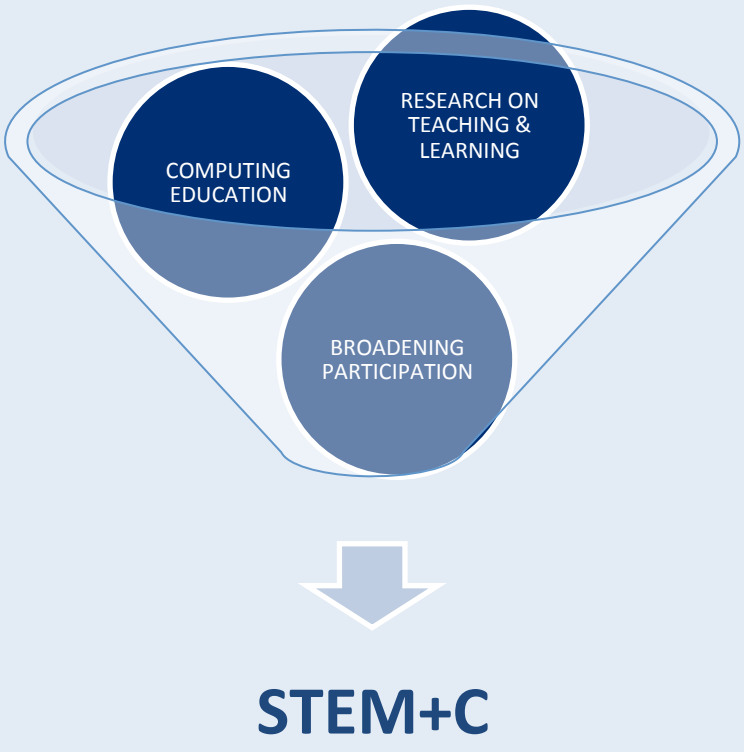
Advanced Cyberinfrastructure

- ACI Mission: To support advanced cyberinfrastructure to *accelerate* discovery and innovation *across all disciplines*
  - coordinates CI across ***all*** of NSF

- Recent History:
  - 2003 Atkins report: *Revolutionizing Science and Engineering through Cyberinfrastructure*
  - OCI established July 2005
  - ACI established Jan. 2013
  - NSF review of ACI realignment in 2016: 3-years-out reflection & review with broad community input



STEM + Computing (STEM+C) Partnerships



- Partnerships:
  - CISE, EHR
  - Deep community partnerships via alliances
  - Industry and nonprofit
- Increase number & diversity of K-14 students & teachers who develop & practice computational competencies
  - CS10K is transforming the computing education pipeline
  - CB/NSF CS Principles

CISE-AC working group on EWF

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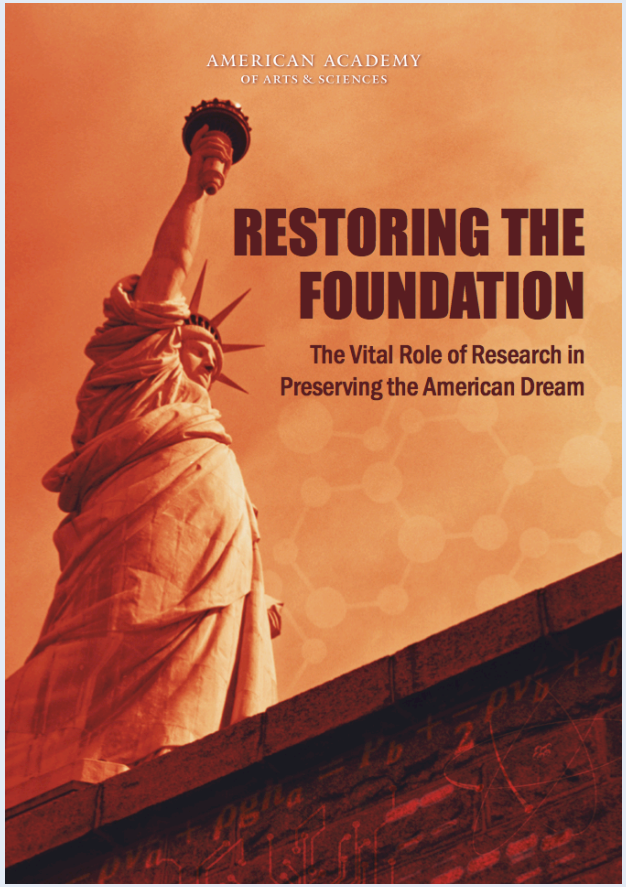
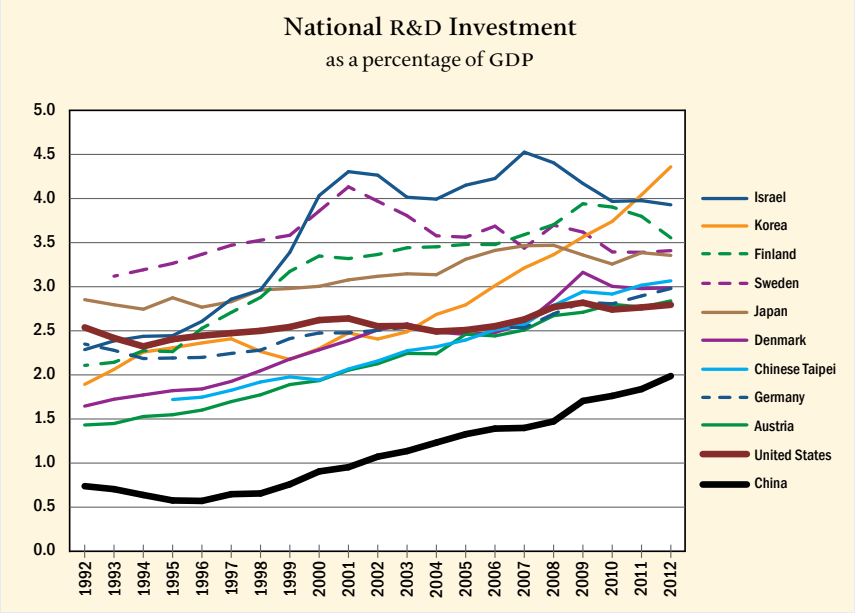
Challenge: Research investment



American Academy of Arts & Sciences, 2014, available at www.aau.edu/WorkArea/DownloadAsset.aspx?id=15491.

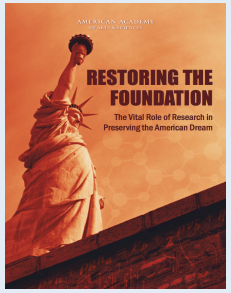


- R&D: Engine of innovation, generating new discoveries, stimulating job growth
- US: Now 10th in national R&D (% GDP)
- Investment federal support for basic research down 13% from 10 years ago (% of GDP)

Partnerships: Many dimensions

Partnerships **build capacity**, **leverage resources**, **increase the speed of translation** from discovery to innovation

- NSF/SRC: SaTC STARRS
- NSF/Intel Partnerships (VEC, CPS)
- Innovation Transition (InTrans) DCL for Expeditions, Frontier projects



Prescription 3: Regain America's Standing as an Innovation Leader by Establishing a More Robust National Government-University-Industry Research Partnership

New CISE-AC working group on partnerships

Partnerships: Many dimensions

Partnerships **build capacity**, **leverage resources**, **increase the speed of translation** from discovery to innovation

- Cyber Physical Systems (CPS): DHS, DOT, NASA, NIH
- National Robotics Initiative (NRI): DARPA, NASA, NIH, USDA
- Smart and Connected Health (SCH): NIH
- Collaborative Research in Computational Neuroscience (CRCNS): NIH

all joint with other NSF directorates

Partnerships: Many dimensions

Partnerships **build capacity**, **leverage resources**, **increase the speed of translation** from discovery to innovation

- Collaborative Research in Computational Neuroscience (CRCNS): Germany, France, Israel
- US-Israel: USICCS, SaTC DCL
- NSF-Germany: automation design DCL
- US-Japan: Big Data and Disaster Research (BDD); JUNO
- NSF-Finland: WIFUS

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An expanding and expansive vision of CISE

An expanding and expansive vision of CISE

Assistive technologies, affective computing, social informatics, mind/machine interface, brain

Science, engineering, humanities health, security, environment. energy, transport, commerce, education

Nano, molecular, optical, quantum

Smart vehicles & buildings, cyber-physical systems, swarms, mobile/cloud

An expanding and expansive vision of CISE

Human-centered computing

Assistive technologies, affective computing, social informatics, mind/machine interface, brain

Science, societal applications

Science, engineering, humanities health, security, environment. energy, transport, commerce, education

Nano, molecular, optical, quantum

Smart vehicles & buildings, cyber-physical systems, swarms, mobile/cloud

Changing "physicalness" of computing

computing embedded around us

CISE's commitment to research and education

- CISE: **rich intellectual agenda** – highly creative, highly interactive, with enormous possibilities for changing the world!
- **Balanced portfolio** of activities
- Thriving basic research community foundational for long-term **discovery** & **innovation**, **economic prosperity**, **national security**
- Growing investment in **cyberinfrastructure** is crucial to accelerating scientific discovery and engineering innovation across all disciplines
- Investments in **research**, **education**, **and infrastructure** have returned exceptional dividends to our Nation

Thanks!

Follow us on Twitter
@NSF_CISE